IN THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application. An identifier indicating the status of each claim is provided.

Listing of Claims

1. (Original) A thin film piezoelectric device including a substrate having a plurality of vibration spaces and a piezoelectric laminated structure formed on the substrate, a plurality of thin film piezoelectric resonators being formed facing the vibration spaces, wherein the piezoelectric laminated structure has at least a piezoelectric film and a metal electrode formed on at least a part of each of opposite surfaces of the piezoelectric film, the piezoelectric laminated structure comprises diaphragms positioned facing the vibration spaces, and a support area other than the diaphragms, at least one set of two adjacent thin film piezoelectric resonators are electrically connected to each other through the metal electrode, the thin film piezoelectric device comprising at least one set of two adjacent thin film piezoelectric resonators in which D0 is a distance between the centers of the diaphragms of the two electrically connected adjacent thin film piezoelectric resonators and D1 is a length of a segment of a support area on a straight line passing through centers of the diaphragms of two electrically connected adjacent thin film piezoelectric resonators, and a ratio D1/D0 is 0.1 to 0.5.

2. (Original) The thin film piezoelectric device according to claim 1, wherein the ratio D1/D0 is in a range of 0.1 to 0.5 with respect to all the sets of two electrically connected adjacent thin film piezoelectric resonators.

3. (Original) The thin film piezoelectric device according to claim 1, wherein each of the vibration spaces is formed by a via hole extending from the surface of the substrate on which the piezoelectric laminated structure is formed to the opposite surface, and a side wall surface of the via hole forms a slant angle in a range of 80 to 100.degree. with respect to the surface of the substrate on which the piezoelectric laminated structure is formed.

4. (Original) The thin film piezoelectric device according to claim 1, wherein the piezoelectric laminated structure comprises a lower electrode constituting the metal electrode, the piezoelectric film, and an upper electrode constituting the metal electrode stacked in order from the substrate side in at least one thin film piezoelectric resonator.

5. (Original) The thin film piezoelectric device according to claim 4, wherein the upper electrode of the at least one thin film piezoelectric resonator comprises two electrode portions.

6. (Original) The thin film piezoelectric device according to claim 1, wherein the piezoelectric laminated structure comprises a lower electrode constituting the metal electrode, a first piezoelectric film, an inner electrode constituting the metal electrode, a second piezoelectric film, and an upper electrode constituting the metal electrode stacked in order from the substrate side in at least one thin film piezoelectric resonator.

7. (Previously Presented) The thin film piezoelectric device according to claim 1, wherein at least one insulating layer of silicon oxide and/or silicon nitride and/or aluminum nitride as a main component is attached to the diaphragm.

8. (Previously Presented) The thin film piezoelectric device according to claim 1, wherein an insulating layer comprising at least one layer of silicon oxide and/or silicon nitride and/or aluminum nitride as a main component intervenes only between the support area of the piezoelectric laminated structure and the substrate.

9. (Original) The thin film piezoelectric device according to claim 1, wherein the piezoelectric film is an oriented crystal film represented by a general formula Al.sub.1-xGa.sub.xN (where 0<x<1) and consists of a solid solution of aluminum nitride and gallium nitride showing a c-axis orientation, and a rocking curve half value width (FWHM) of a diffraction peak of a (0002) surface of the film is 3.0.degree. or less in at least one thin film piezoelectric resonator.

10. (Original) The thin film piezoelectric device according to claim 1, wherein the piezoelectric film is a zinc oxide thin film showing a c-axis orientation, and a rocking curve half value Width (FWM) of a diffraction peak of a (0002) surface of the film is 3.0.degree. or less in at least one thin film piezoelectric resonator.

11. (Original) The thin film piezoelectric device according to claim 1, wherein the piezoelectric film is a lead titanate thin film or a lead zirconate titanate thin film in at least one thin film piezoelectric resonator.

12. (Original) The thin film piezoelectric device according to claim 1, wherein the planar shape of one of the diaphragms has two pairs of opposite sides, and at least one pair of opposite sides is formed to be non-parallel in at least one thin film piezoelectric resonator.

13. (Original) The thin film piezoelectric device according to claim 1, wherein at least a part of the planar shape of one of the diaphragms is formed by a non-square irregular polygonal shape in at least one thin film piezoelectric resonator.

14. (Original) The thin film piezoelectric device according to claim 1, wherein the planar shape of one of the diaphragms is formed, by a non-square irregular polygonal shape including a curved portion in at least a part of the shape in at least one thin film piezoelectric resonator.

15. (Original) The thin film piezoelectric device according to claim 1, the thin film piezoelectric device being a thin film piezoelectric filter.

16. (Original) The thin film piezoelectric device according to claim 15, wherein the thin film piezoelectric filter comprises a ladder type circuit comprising a plurality

of thin film piezoelectric resonators connected in series and at least one of the thin film piezoelectric resonators branched from/connected to the plurality of resonators connected in series.

17. (Original) The thin film piezoelectric device according to claim 1, the thin film piezoelectric device being a duplexer comprising a plurality of thin film piezoelectric filters.

18. (Original) The thin film piezoelectric device according to claim 17, wherein the thin film piezoelectric filter comprises a ladder type circuit comprising a plurality of thin film piezoelectric resonators connected in series and at least one of the thin film piezoelectric resonators branched from/connected to the plurality of resonators connected in series.

19. (Original) A method of manufacturing the thin film piezoelectric device according to claim 1, comprising the steps of: forming the piezoelectric laminated structure on the substrate comprising a semiconductor or an insulator; and thereafter forming the vibration spaces in the substrate from a side opposite to the side on which the piezoelectric laminated structure is fabricated by a deep graving type reactive ion etching process.

20 - 36. (Cancelled)

37. (Original) The thin film piezoelectric device according to claim 2, wherein the ratio D1/D0 is in a range of 0.18 to 0.3 with respect to all the sets of two electrically connected-adjacent thin film piezoelectric resonators.

38. (Original) The thin film piezoelectric device according to claim 7, wherein assuming that a thickness of the piezoelectric film is t, and a thickness of the insulating layer is t', 0.1.ltoreq.t'/t.ltoreq.0.5 is satisfied.

39. (Original) The thin film piezoelectric device according to claim 1, wherein at least one of metal electrodes comprises a main electrode layer and an adhesive layer.

40. (Original) The thin film piezoelectric device according to claim 1, wherein a thickness of the piezoelectric film is in a range of 0.98 to 1.57 .mu.m.

41. (Original) The thin film piezoelectric device according to claim 1, wherein the piezoelectric laminated structure comprises a lower electrode constituting the metal electrode, the piezoelectric film, and an upper electrode constituting the metal electrode stacked in order from the substrate side, and a total of thicknesses of the lower electrode and the upper electrode is in a range of 320 to 485 nm.

42. (Original) The thin film piezoelectric device according to claim 41, wherein a thickness of the lower electrode is in a range of 170 to 235 nm.

43. (Original) The thin film piezoelectric device according to claim 41, wherein a thickness of the upper electrode is in a range of 150 to 250 nm.

44. (Original) The thin film piezoelectric device according to claim 1, wherein the piezoelectric laminated structure comprises a lower electrode constituting the metal electrode, the piezoelectric film, and an upper electrode constituting the metal electrode stacked in order from the substrate side, and a ratio of a total of thicknesses of the lower electrode and the upper electrode to a thickness of the piezoelectric film is in a range of 0.255 to 0.392.

45. (Original) The thin film piezoelectric device according to claim 39, wherein the piezoelectric laminated structure comprises a lower electrode constituting the metal electrode, the piezoelectric film, and an upper electrode constituting the metal electrode stacked in order from the substrate side, and a ratio of a total of thicknesses of the lower electrode and the upper electrode to a thickness of the piezoelectric film is in a range of 0.255 to 0.452.

46. (Withdrawn) A method of forming an acoustic resonator, comprising:

depositing an adhesive layer;

depositing an electrode layer containing Molybdenum (Mo) or Tungsten (W) on the upper surface of the adhesive layer; and

depositing a layer of piezoelectric material on the electrode layer, wherein the adhesive layer comprises one of Titanium (Ti), Zirconium (Zr) and Chromium (Cr).

47. (Withdrawn) The method according to claim 46, wherein the adhesive layer and the electrode layer are deposited by DC magnetron sputtering.

48. (Original) A thin film piezoelectric device including a substrate having a plurality of vibration spaces, an insulating layer formed on an upper surface of the substrate, a piezoelectric laminated structure formed on an upper surface of the insulating layer, diaphragms positioned facing the vibration spaces, and a support area in which the piezoelectric laminated structure and the insulating layer are supported by the substrate, a plurality of thin film piezoelectric resonators being formed facing the vibration spaces,

wherein the piezoelectric laminated structure has at least a piezoelectric film and a metal electrode formed on at least a part of each of the opposite surfaces of the piezoelectric film, each diaphragm comprises a portion of the piezoelectric laminated structure and a portion of the insulating layer, and a support area comprises another portion of the piezoelectric laminated structure and at least a portion of the insulating layer, and

wherein at least one set of two adjacent thin film piezoelectric resonators are electrically connected to each other through the metal electrode, the thin film piezoelectric device comprising at least one set of two adjacent thin film piezoelectric resonators in which DO is a distance between the centers of the diaphragms of the two electrically connected adjacent thin film piezoelectric resonators and D1 is a length of a segment of the support area on a straight

line passing through centers of the diaphragms of two electrically connected adjacent thin film piezoelectric resonators, and a ratio DI/DO is 0.1 to 0.5.

49. (Original) The thin film piezoelectric device according to claim 48, wherein the ratio D1/DO is in a range of 0.1 to 0.5 with respect to all the sets of two electrically connected adjacent thin film piezoelectric resonators.

50. (Original) The thin film piezoelectric device according to claim 48, wherein each of the vibration spaces is formed by a via hole extending from the surface of the substrate on which the insulating layer is formed to the opposite surface, and a side wall surface of the via hole forms a slant angle in a range of 80 to 100° with respect to the surface of the substrate on which the insulating layer is formed.

51. (Original) The thin film piezoelectric device according to claim 48, wherein the piezoelectric laminated structure comprises a lower electrode constituting the metal electrode, the piezoelectric film, and an upper electrode constituting the metal electrode stacked in order from the insulating layer side in at least one thin film piezoelectric resonator.

52. (Original) The thin film piezoelectric device according to claim 51, wherein the upper electrode of the at least one thin film piezoelectric resonator comprises two electrode portions.

53. (Original) The thin film piezoelectric device according to claim 48, wherein the piezoelectric laminated structure comprises a lower electrode constituting the metal electrode, a first piezoelectric film, an inner electrode constituting the metal electrode, a second piezoelectric film, and an upper electrode constituting the metal electrode stacked in order from the insulating layer side in at least one thin film piezoelectric resonator.

54. (Original) The thin film piezoelectric device according to claim 48, wherein the insulating layer comprises at least one layer of silicon oxide and/or silicon nitride and/or aluminum nitride as a main component.

55. (Original) The thin film piezoelectric device according to claim 48, wherein the piezoelectric film is an oriented crystal.film represented by a general formula Al_1-xGa_xN (where $0 < x < 1$) and consists of a solid solution of aluminum nitride and gallium nitride showing a c-axis orientation, and a rocking curve half value width (FWHM) of a diffraction peak of a (0002) surface of the film is 3.0° or less in at least one thin film piezoelectric resonator.

56. (Original) The thin film piezoelectric device according to claim 48, wherein the piezoelectric film is a zinc oxide thin film showing a c-axis orientation, and a rocking curve half value width (FWHM) of a diffraction peak of a (0002) surface of the film is 3.0° or less in at least one thin film piezoelectric resonator.

57. (Original) The thin film piezoelectric device according to claim 48, wherein the piezoelectric film is a lead titanate thin film or a lead zirconate titanate thin film in at least one thin film piezoelectric resonator.

58. (Original) The thin film piezoelectric device according to claim 48, wherein the planar shape of one of the diaphragms has two pairs of opposite sides, and at least one pair of opposite sides is formed to be non-parallel in at least one thin film piezoelectric resonator.

59. (Original) The thin film piezoelectric device according to claim 48, wherein at least a part of the planar shape of one of the diaphragms is formed by a non-square irregular polygonal shape in at least one thin film piezoelectric resonator.

60. (Original) The thin film piezoelectric device according to claim 48, wherein, the planar shape of one of the diaphragms is formed by a non-square irregular polygonal shape including a curved portion in at least a part of the shape in at least one thin film piezoelectric resonator.

61. (Original) The thin film piezoelectric device according to claim 48, the thin film piezoelectric device being a thin film piezoelectric filter.

62. (Original) The thin film piezoelectric device according to claim 61, wherein the thin film piezoelectric filter comprises a ladder type circuit comprising a plurality of thin film

piezoelectric resonators connected in series and at least one of the thin film piezoelectric resonators branched from/connected to the plurality of resonators connected in series.

63. (Original) The thin film piezoelectric device according to claim 48, the thin film piezoelectric device being a duplexer comprising a plurality of thin film piezoelectric filters.

64. (Original) The thin film piezoelectric device according to claim 63, wherein the thin film piezoelectric filter comprises a ladder type circuit comprising a plurality of thin film piezoelectric resonators connected in series and at least one of the thin film piezoelectric resonators branched from/connected to the plurality of resonators connected in series.

65. (Original) A method of manufacturing the thin film piezoelectric device according to claim 48, comprising the steps of forming the insulating layer on the substrate comprising a semiconductor or an insulator; forming the piezoelectric laminated structure on the insulating layer; and thereafter forming the vibration spaces in the substrate from a side opposite to the side on which the insulating layer is form by a deep graving type reactive ion etching process.

66. (Original) The thin film piezoelectric device according to claim 49, wherein the ratio D1/DO is in a range of 0.18 to 0.3 with respect to all the sets of two electrically connected adjacent thin film piezoelectric resonators.

67. (Original) The thin film piezoelectric device according to claim 48, wherein assuming that a thickness of the piezoelectric film is t, and a thickness of the insulating layer is t', $0.1 \leq t'/t \leq 0.5$ is satisfied.

68. (Original) The thin film piezoelectric device according to claim 48, wherein at least one of metal electrodes comprises a main electrode layer and. an adhesive layer.

69. (Original) The thin film piezoelectric device according to claim 48, wherein a thickness of the piezoelectric film is in a range of 0.98 to 1.57 μm.

70. (Original) The thin film piezoelectric device according to claim 48, wherein the piezoelectric laminated structure comprises a lower electrode constituting the metal electrode, the piezoelectric film, and an upper electrode constituting the metal electrode stacked in order from the insulating layer side, and a total of thicknesses of the lower electrode and the upper electrode is in a range of 320 to 485 nm.

71. (Original) The thin film piezoelectric device according to claim 70, wherein a thickness of the lower electrode is in a range of 170 to 235 nm.

72. (Original) The thin film piezoelectric device according to claim 70, wherein a thickness of the upper electrode is in a range of 150 to 250 nm.

73. (Original) The thin film piezoelectric device according to claim 48, wherein the piezoelectric laminated structure comprises a lower electrode constituting the metal electrode, the piezoelectric film, and an upper electrode constituting the metal electrode stacked in order from the insulating layer side, and a ratio of a total of thicknesses of the lower electrode and the upper electrode to a thickness of the piezoelectric film is in a range of 0.255 to 0.392.

74. (Original) The thin film piezoelectric device according to claim 68, wherein the piezoelectric laminated structure comprises a lower electrode constituting the metal electrode, the piezoelectric film, and an upper electrode constituting the metal electrode stacked in order from the insulating layer side, and a ratio of a total of thicknesses of the lower electrode and the upper electrode to a thickness of the piezoelectric film is in a range of 0.255 to 0.452.